BOTANY

Title: **Vascular Flora of the Greater Yellowstone Area**

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Objectives: 1.) To collect vascular plant specimens as vouchers for distribution maps to be included in the investigator's flora of the Greater Yellowstone Area. 2.) To collect specimens of species that have not been vouchered for Yellowstone National Park (YNP) but have been reported for YNP. 3.) To find and collect vascular plant species that have not been reported for YNP. 4.) To produce a complete up-to-date flora of YNP and surrounding region.

Findings: *Thalictrum alpinum* L., Alpine Meadowrue, was collected (E. Evert 35826, July 17, 1998) from Swan Lake Flat at the edge of a swale where a small population occurs. This species previously unreported for YNP is known to occur at only four other locations in the Greater Yellowstone Area. Specimens are to be deposited at the Yellowstone Herbarium and the Rocky Mountain Herbarium, University of Wyoming.

Title: **Pest Trend Permanent Plots for White Pine Rust**

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Objectives: Long term monitoring of three plots on the eastern side of the Absaroka Mountains for white pine blister rust disease.

Findings: Plots were installed near Eleanor Lake, T52N. R110W. Sec.18. Disease and tree data, increment tree cores, and *Ribes* plant specimens were collected. The Yellowstone National Park plots

have a moderate level (12%) of white pine blister rust disease on whitebark pines, the host tree of the disease.

Title: **Trends in Climate and the Spread of White Pine Blister Rust in the Greater Yellowstone Ecosystem**

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Objectives: In the summer of 1998, I obtained GIS coverages for a study relating infection levels of white pine blister rust to known forest habitat and cover types, and additional environmental variables. Preliminary to the GIS study, I have conducted a study of the region's climate from weather data obtained through the US Natural Resource Conservation Service. The aim of the study is to determine the current climatic conditions, which exist in the GYE with specific reference to the White Pine blister rust fungus, and its spread to the subalpine tree, whitebark pine. Secondly, through relating known infection and mortality levels of whitebark pine from blister rust through a GIS study, I aim to link environmental variables to the spread of this disease. Lastly, I am looking at scenarios of future blister rust change under climate change conditions.

Findings: Currently, I am in the finalizing stages of the review of climate data, and the assessment of climate change scenarios for the GYE. These findings will be published as a book chapter put out by the National Wildlife Federation. I have found that climate, although not most favorable to the spread of blister rust in the GYE, is not limiting, and that it is likely blister rust will increasingly be a source of mortality to whitebark pine in the GYE. Under projected climate change conditions, blister rust is likely to be even more of a problem region-wide. I am still in the preliminary stages of my GIS analysis.

Title: **Development of a Prototype Ecological Monitoring Program**

Principal Investigator: Terry McLendon
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Additional Investigators: W. Michael Childress

Objectives: 1.) Evaluate one to two revegetation/restoration projects at Yellowstone NP. 2.) Apply the EDYS ecological model to the revegetation/restoration projects and associated reference areas.

Findings: A vegetation monitoring design was established at two revegetation/restoration projects in July 1997. One was in a lodgepole pine community and the second was in a big sagebrush community.

Plots are to be established in both communities in 1999. Species composition and above and below ground biomass data are to be collected from these plots in the summers of 1999-2001. The 1999 data will be used to parameterize the EDYS ecological model for the sites. The model will be used to simulate successional dynamics and these results will be used to evaluate revegetation projects in these communities. The data collected in 2000-01 will be used to validate and improve the model. Initial simulation results are expected by summer of 2000. These will be supplied to Yellowstone National Park on an annual basis beginning in 2000.

Title: **AVHRR-NDVI as a Predictor of Temporal Change in Montana Grasslands**

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Additional Investigators: Dr. Jerry Nielsen, David Thoma

Objectives: Determine degree to which AVHRR-NDVI satellite imagery can be used to predict vegetative above-ground biomass, or vegetative nitrogen content in grasslands.

Findings: The first field season of this project is complete. AVHRR-NDVI predicted live biomass well

($r^2 = 0.637$) for six grasslands when live biomass was below 1800 kg/ha. The strongest correlation with live biomass for an individual study area was $r^2 = 0.715$. Above 1800 kg/ha, a saturation asymptote was exceeded where predictive capability declined. AVHRR-NDVI did not predict dead biomass ($r^2 = 0.206$) at any level, or predict vegetative nitrogen content ($r^2 = 0.034$).

Title: **Wetland Conservation Planning**

Principal Investigator: Mr. Robert Moseley
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Objectives: Compile a centralized Wetland Information System for Idaho and prepare wetland conservation plans by watersheds. The first watershed to be done under this project is the Henrys Fork Basin.
Findings: Inventories were conducted in the Henry's Fork Basin but not in Yellowstone National Park this year.

Title: **Remote Sensing of Aspen Change on the Northern Range**

Principal Investigator: Dr. William J. Ripple
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Additional Investigators: Eric J. Larsen

Objectives: 1.) Using aerial photography, map changes in woody vegetation on Yellowstone National Park's (YNP) northern range and on selected comparable plots in the Shoshone National Forest (Clarks Fork of the Yellowstone river area) and Gallatin National Forest (Gardiner Ranger District). 2.) Compare changes in aspen/conifer canopy coverage on the northern range plots with changes observed on the Shoshone and Gallatin National Forest plots. 3.) Integrate field collected transect and core data with remote sensing results to attempt to determine the causes for any observed differences among the

study plots.

Findings: One hundred aspen plots were randomly chosen on the northern range of YNP along with 40 each in the Clarks Fork and Sunlight Basin study areas. Using aerial photography, aspen/conifer cover change for the period 1954 to 1992 (YNP) and 1958 to 1995 (Clarks Fork/Sunlight) is in progress.

During the 1997 field season, transect data was collected on 91 of the study plots, including 50 in YNP, 13 on the Clarks Fork, and 28 in the Sunlight Basin. Preliminary results indicate that YNP aspen stands have a different age structure than those in the Clarks Fork or Sunlight Basin areas. The data are being analyzed to compare ramet densities, the degree of conifer invasion, bark damage to boles, and intensity of grazing pressure on ramets.

At the conclusion of the 1998 field season, data had been obtained from 94 randomly selected plots in YNP, 97 plots in the Shoshone National Forest, and 67 plots in the Gallatin National Forest. Preliminary analysis of the data indicates that YNP aspen stands may have a different age structure than those in the adjoining national forests, including the elk wintering areas of the Sunlight/Crandall basins of the Shoshone National Forest. The data are being analyzed to compare age distributions, sucker densities, bark damage to boles, browsing intensity, and the degree of conifer invasion in aspen stands. Using paired sets of aerial photographs, aspen/conifer cover change for the period 1954-1992 (1958-1995 in the national forests) is still in progress with no findings to report as of yet.

Title:	**Effects of Water Stress and Elk Herbivory on Willows**
Principal Investigator:	Dr. Francis Singer
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Additional Investigators:	Rex G. Cates, Linda C. Zeigenfuss

Objectives: Isolate the effects of drought stress versus intense herbivory on aboveground biomass production, nutrient status, and defense chemistry of willows through experimental manipulation.

Findings: Initial results show that willows subjected to no herbivory or 50% removal of annual production had greater height and catkin production than those subjected to 100% removal of production after four years of manipulation (1992-1995). Levels of carbon, nitrogen, and protein were lower, and cellulose was higher in *Salix pseudomonticola* plants that were subject to 100% removal compared to unmanipulated plants. Levels of several minerals were greater in 0% herbivory plants after four years of treatment; however, results after three years showed treated plants with higher mineral levels than 0% treatments. This implies that there may be short-term increases in minerals due to browsing or other factors, such as precipitation and temperature. Analysis of defensive chemistry has

found no significant differences in soluble carbohydrate content, phenolics, or tannins. This is contrary to responses found for similar work in Rocky Mountain National Park where conditions are more favorable for growth. Laboratory and data analysis has been completed at this point, and manuscripts for submission to refereed journals and reports to Yellowstone National Park are being written.

Title: **Physiology of Thermotolerant Plants in Yellowstone Park**

Principal Investigator: Dr. Richard Stout
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Objectives: Our three main objectives are to monitor rhizosphere and surface temperatures of vascular plants and mosses living in geothermally heated environments, to collect plant material from some of these plants for protein and nucleic acid analyses, and to collect seeds from some of these plants for physiological studies in the lab.

Findings: In 1998, we found that rhizosphere temperatures of plants living in geothermal soils ranged from 25 to 50 degrees C not only in the summer, but also during the winter months. We also found that heat shock protein expression was elevated in plant tissues exposed to temperatures above 35 degrees C, but not in tissues at temperatures below 35 degrees C. We also collected seeds from selected individuals of the following species: *Dichanthelium lanuginosum* and *Panicum capillare*.

Title: **Mechanisms of Grazing Impacts on Plant Competition**

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Objectives: Determine how plant species that have been found to compensate for herbivory compete with one another following tissue loss, so that we can examine how the plant community structures itself in these grazed ecosystems.

Findings: Analysis of plant biomass, nitrogen content, and soil nitrogen content was completed this year. These data corroborate the initial indications from last year's analysis of plant morphology and physiology. The three species in the artificial communities, *Bromus carinatus, Agropyron caninum*, and *Phleum pratense* appear to have a very simplistic competitive network. When *Phleum* was present, both of the other species did poorly. When *Phleum* was present only as the target plant, then the other species did better. *Bromus* was least affected, and *Agropyron* was dramatically reduced by the presence of *Phleum*. When *Phleum* was clipped, the nitrogen content of the other species was reduced, regardless of their clipping status. Thus, clipped *Phleum* was removing soil N at rates greater than could be matched by the other species. Soil N contents were quite high (averaging ~ 3000 ppm) and thus did not appear to be limiting to growth in this environment. The fact that *Phleum* was able to reduce the nitrogen content of the other two species in this situation is remarkable. Further analyses and object based modeling will be completed this year, as will submission of at least two manuscripts for publication.

Title: **Sagebrush Ecology and Mule Deer Relationships on the Northern Range**

Principal Investigator: Dr. Carl Wambolt

See Ecology

Title: **Declining Native Plant Diversity Caused by Invasive Weeds and Grazing**

Principal Investigator: Dr. Thomas Stohlgren
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Additional Investigators: Lisa Schell, Brian Van den Heuvel

Objectives: 1.) Identify major ecosystem level stressors and determine the diversity of rangeland grass species. 2.) Evaluate habitat and wildlife management practices, including grazing. 3.) Document the effects of noxious weeds/exotic plants on native flora. 4.) Develop standard survey techniques and protocols for vegetation sampling.

Findings: We found no significant differences in plant species richness (native and exotic) inside compared to outside of the three grazing exclosures (Lamar, Blacktail, and Junction Butte). The cover

of native species was usually higher inside the Yellowstone exclosures than outside. The exception was the sampling plot immediately outside Blacktail exclosure. The cover of native grass, *Agropyron spicatum*, varied greatly at the three exclosure sites, having inconsistent patterns in grazed or ungrazed plots. Overall, our sampling techniques of foliar cover found no consistent differences in the cover of forbs, grasses, or bare ground inside and outside exclosures. However, shrub cover in the grazed plots was consistently less than in the ungrazed plots. The cover of *Festuca idahoensis* was higher in grazed plots relative to ungrazed exclosure plots. Our addition of a third, 1000 meter sampling plot, randomly located in the grazed vegetation type, confirmed the natural patchiness of vegetation, spatially heterogeneous grazing, selective grazing, and inconsistent responses to grazing.

Title: **Mechanisms of Grazing Impacts on Plant Competition**

Principal Investigator: Dr. Linda Wallace

See Ecology

Title: **Survey and Assessment of Yellowstone Sand Verbena**

Principal Investigator: Ms. Jennifer Whipple
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Objectives: Yellowstone sand verbena (*Abronia ammophila*) is an endemic that is currently only known from a two-mile stretch of beach along the shoreline of Yellowstone Lake. There are extensive areas of similar shoreline habitat which have not been surveyed for Yellowstone sand verbena. During the summer of 1998, all of the unsurveyed possible habitat will be searched for this species. Also, permanent monitoring plots will be established.

Findings: Complete surveys of Yellowstone Lake, Delusion Lake, and Lewis Lake were completed during the 1998 field season. Three new sites of Yellowstone sand verbena were located. All known sites were counted in 1998 using a one meter squared grid system so that trends in any part of the population could be monitored through time. In addition, four permanent belt transects were established. A total of 8,325 sand verbenas were found among all of the sites. Determination of whether large sand verbena mats were composed of one or more individuals was difficult, so this number is a minimum count for the total population. Approximately 45% of the plants present last summer represent probable recruitment of the last two years. Less than 5% of the plants were at the three new sites,

thus the primary conservation concern needs to be still focused on the main population.

Title: **Yellowstone Flora**

Objective: The vascular plant flora of Yellowstone, even though investigated for approximately 120 years, is not completely known. The primary focus of this project is to improve the current knowledge of the flora of the park through in-depth collecting, especially of areas in the park which have not been previously studied. This includes inventory of the occurrence and range of native taxa and also involves the documentation of the arrival and spread of exotic species. In addition, collection of specimens for the Yellowstone herbarium will improve the value of the facility for both NPS personnel and outside researchers.

Findings: Ongoing inventory of vascular plants and collection for the Yellowstone National Park Herbarium. Four species of vascular plants previously not reported as occurring within the park were discovered. *Schoenocrambe linifolia* (Nutt.) Greene, plains mustard, and *Astragalus lotiflorus* Hook., lotus milkvetch, were both discovered in the northern part of the park. These native species are presumed to have been a long-term component of Yellowstone's flora that had been previously overlooked. Additionally, *Solidago rigida* L. var. *humilis* Porter, stiff goldenrod, was located on the Dunraven road during surveys for species of special concern. Stiff goldenrod is presumed to be a casual introduction since there was only one plant present on the immediate roadside. *Ranunculus acris* L., meadow buttercup, is an exotic species that has become established in the vicinity of the Bechler Ranger Station.

Title: **Postglacial Fire Frequency and its Relation to Long-Term Vegetational and Climatic Changes in Yellowstone Park**

Principal Investigator: Dr. Cathy Whitlock

See Fire